

SUBJECT: Increasing the Number of Experiments
Planned for Performance During the
First AAP Mission - Case 610

DATE: June 17, 1969

FROM:

ABSTRACT

Thirty-nine experiments have been assigned to the AAP-1/AAP-2 mission. A recent flight planning performed by Martin/Denver for MSC successfully scheduled all but seven of these experiments. The complete exclusion of six experiments and the partial exclusion of a seventh resulted from limitations in available crew time imposed by experiment requirements and scheduling ground rules.

The present study found the exclusion of those experiments to be largely a consequence of assumed requirements for: (1) continuous manning of the CM throughout the mission; (2) two-man operation of certain experiments that impose pointing requirements on the orbital assembly; and (3) the allocation of mission days 8, 14, and 21 for "mission evaluation," which is open time reserved from experiment scheduling. "Mission evaluation" periods presently remove from availability ~15% of the crew time (man-hours) otherwise available for experiments.

Continuous manning of the CM is presently required by MSC only until the completion of Workshop activation, rather than throughout the entire mission. The question of which "pointing" experiments require only one crewman for their operation and which require two men has yet to be resolved. It is recommended that the need for weekly "mission evaluation" days, as presently defined, be re-examined with a view toward their possible elimination from pre-flight mission plans in favor of real time contingency planning during the mission.

If Experiments S019 and S020 are found to be completely operable by one crewman and if the present "mission evaluation" periods are deleted, all experiments currently assigned by NASA Headquarters for performance on the AAP-1/AAP-2 mission can be completely scheduled except:

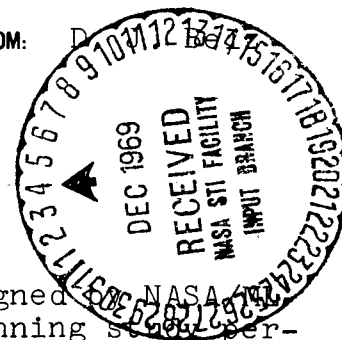
- a. M508 and M509, 50% of which can be scheduled. (Adequate crew time for the remaining 50% still would not exist.)
- b. S073, for which scheduling opportunities cannot be evaluated. (Requirements and constraints have yet to be established.)

If, in addition, Experiments D019 and D020 are cancelled as a result of the cancellation of the MOL program, 67% rather than 50% of Experiment M508 can be scheduled.

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(NASA-CR-106871) INCREASING THE NUMBER OF
EXPERIMENTS PLANNED FOR PERFORMANCE DURING
THE FIRST AAP MISSION (Bellcomm, Inc.) 15 P



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MEMORANDUM FOR FILE

1.0 Introduction

Thirty-nine experiments have been assigned by NASA/ML to the AAP-1/AAP-2 mission (Reference 1). Of these, thirty-three require in-flight participation by the crew. A recent flight planning study performed by Martin/Denver for MSC successfully scheduled all but seven of the crew-operated experiments (Reference 2). The complete exclusion of six experiments and 50% of a seventh experiment resulted from limitations in available crew time imposed by scheduling ground rules and experiment requirements. Although Reference 2 is not a NASA flight plan, it is of considerable interest since MSC's forthcoming Baseline Reference Flight Plan for AAP-1/AAP-2 will be based upon it (Reference 3). In addition, the results of that study were reported by MSC/AAPO at the Baseline Configuration Review held at NASA Headquarters in May 1969 and thereby given wide distribution.

This memorandum explores the possibility of scheduling the seven remaining crew-operated experiments for performance during the AAP-1/AAP-2 mission.

2.0 Experiment Requirements

The seven experiments not included or completed in the crew timelines of Reference 2 are:

Experiment Number	Experiment Name	% Completed During Mission
M508	Astronaut EVA Hardware Evaluation	0.
M509	Astronaut Maneuvering Equipment	0.
S018	Micrometeoroid Collection	0.
S019	UV Stellar Astronomy	50.
S020	X-Ray/UV Solar Photography	0.
S073	Gegenschein/Zodiacal Light	0.
T020	Foot Controlled Maneuvering Unit	0.

With the exception of Experiment S018, scheduling requirements of these experiments are shown in the following sections. S018 has been cancelled by the Manned Space Flight Experiments Board and replaced by S149 - "Particle Collection" (Reference 4).

2.1 Experiment M508 - Astronaut EVA Hardware Evaluation*

This experiment is designed to measure and evaluate astronaut skills and selected pieces of EVA hardware during IVA operations. Six separate performances ("runs") of M508 are required. Each individual run requires two astronauts simultaneously for 4.5 hours. Runs are to be conducted on separate mission days to minimize overboard dumping of cabin atmospheric gas through pressure relief valves. Prior to the first run, one crewman is required for 1.5 hours to deploy experiment equipment in the task area; following the last run, one crewman is required for 1.5 hours to stow experiment equipment.

2.2 Experiment M509 - Astronaut Maneuvering Equipment**

The objective of this experiment is to gain increased understanding of astronaut maneuvering dynamics under zero-G conditions. In-flight portions of the experiment are intra-vehicular activities. Performance of M509 consists of four separate

*Reference 5

**Reference 6

runs, with two crewmen required simultaneously during each run. The duration of each run and required crew assignments are as follows:

Run Number	Crewmen	Run Duration (Hours:Minutes)
1	A and B	3:55
2	A and C	3:55
3	A and B	4:05
4	B and C	2:45

Each run is to be conducted on a separate day with at least two days intervening to minimize overboard venting of cabin atmospheric gas.

2.3 Experiment S019 - UV Stellar Astronomy*

The primary objective of S019 is to obtain a number of stellar spectra with sufficient resolution to permit the study of UV line spectra and the spectral energy distributions of early type stars. This experiment will be operated from the Scientific Airlock (SA). Installation of the mirror system and spectrograph in the SA will require one crewman for one-half hour. Observations will be restricted to periods when the spacecraft is not directly illuminated by the sun; seventeen dark-side passes will be required to expose all available film slides, assuming nine exposures per pass. Time required to stow the experiment after the completion of observations has yet to be specified.

2.4 Experiment S020 - X-Ray/UV Solar Photography**

This experiment is designed to obtain photographs of the extreme UV and X-Ray spectrum of the sun in the wavelength band from 10Å to 200Å. It will be mounted in the Scientific Airlock. All experiment requirements can be satisfied by two performances of the following sequence:

Preparation: 35 minutes

Observations: 4 orbits, sun side only

Stowage: 45 minutes

All required operations can be carried out by one crewman.

*Reference 7

**Reference 8

2.5 Experiment S073 - Geggenschein/Zodiacal Light

Operational requirements for this experiment are in the process of being formulated, but have not yet been established (Reference 9).

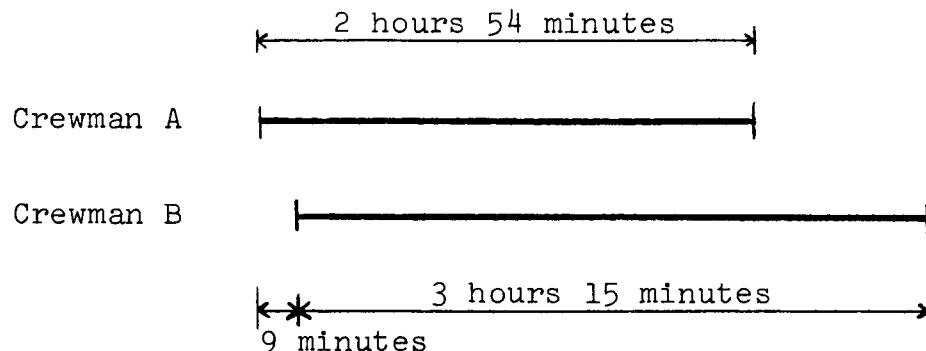
2.6 Experiment S149 - Particle Collection*

The principal objective of S149 is to determine the mass distribution of micrometeorites in near-earth space by studying impact effects on exposed surfaces. Experiment equipment will be deployed outside the vehicle by means of the Scientific Airlock. All operations associated with this experiment can be performed by one crewman. Collecting surfaces will be deployed and retrieved during the AAP-1/AAP-2 mission; additional plates are to be deployed near the end of the mission and retrieved by the crew of AAP-3A. Initial deployment will require 52. minutes of crew time. It is desirable to have a 72 hour initial exposure; however, a duration as short as 8 hours is acceptable. Retrieval will require 61. minutes. The second deployment near the end of the first AAP mission will require 42. minutes.

2.7 Experiment T020 - Foot Controlled Maneuvering Unit**

This experiment is intended to determine the feasibility of using a foot controlled maneuvering unit to provide locomotion for astronauts during EVA. The experiment itself is, however, an intravehicular activity. Operationally, T020 consists of three runs, the first two of which are to occur consecutively. Crew assignments and timelines for each run are shown below:

a. Runs 1 and 2



*Reference 10

**Reference 11

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b. Run 3

Crewman B



Crewman C



55 minutes

3.0 Scheduling Approach and Assumptions

The Martin/Denver crew timelines of Reference 2 do not permit the performance of the seven experiments listed in Section 2.0 of this memorandum. As will be shown below, the exclusion of those experiments is to a large extent the consequence of three requirements assumed in the Martin study: continuous manning of the command module throughout the first AAP mission; two-man operation of certain experiments that impose pointing requirements; and the allocation of Days 8, 14, and 21 for mission evaluation.

All scheduling requirements used by Martin were consistent with flight planning ground rules established by MSC's Flight Crew Operations Directorate (FCOD). Since the publication of Reference 2, however, FCOD has modified its ground rules such that continuous occupancy of the command module by at least one crewman is now required only until the completion of OWS activation, rather than throughout the entire mission (Reference 12). Current planning assumes that the Workshop will be completely activated at the end of the first week of AAP-1/AAP-2. The removal of the command module occupancy requirement during the remaining three weeks of the mission thus provides a degree of crew-scheduling flexibility that was not available to Martin/Denver during the preparation of their timelining study.

Three of the seven AAP-1/AAP-2 experiments that were not completely scheduled in the timelines of Reference 2 impose requirements on the cluster's attitude or orientation. These are S019 - "UV Stellar Astronomy," S020 - "X-Ray/UV Solar Photography," and S073 - "Gegenschein/Zodiacal Light." While the experiments themselves can be performed by one man, it is uncertain at this writing whether or not an additional crewman will be required to manually control the vehicle's orientation with the Workshop Attitude Control System (WACS). Reference 2 conservatively assumed a requirement of two-man operation for Experiments S019, S020, and S073, as well as other experiments with pointing requirements. There is, however, a clear possibility that these and other experiments will be completely operable by only one man (References 2, 9). Although the question of one-man vs two-man operation is presently unresolved, experiments S019 and S020 are treated below as one-man experiments; this is done only for the purpose of examining the effects on crew timelines that would result from the increased scheduling flexibility inherent in one-man as opposed to two-man operation.

The FCOD practice of reserving every seventh day largely for "mission evaluation" deserves some attention. Time formally set aside for mission evaluation is, in practice, "open time reserved from experiment scheduling" (Reference 13). That is, specific tasks to be performed during evaluation periods are not presently being assigned as part of preflight mission planning; allocation of those reserved periods is to be made later, possibly

in real time during the mission. Periods of mission evaluation, as presently defined, thus constitute a margin of available crew time that can be used for contingency operations, for completing experiments and housekeeping tasks that overrun present time estimates, or for additional crew rest and recreation. The flight planning study of Reference 2 allocates a total of 469 man-hours to mission evaluation on Days 8, 14, and 21; this represents 15% of the 461 man-hours identified therein as being available for experiments during the AAP-1/AAP-2 mission.

The experiments presently assigned to AAP-1/AAP-2 by NASA Headquarters but not scheduled for performance in the Martin flight planning study constitute a set of crew tasks that could productively consume much of the time presently allocated to "mission evaluation," should that time be made available for them. This suggests an alternate approach to the problem of contingency operations and presently unforeseen demands on crew time.

Instead of arbitrarily assigning blocks of "mission evaluation" time throughout the mission, such time could be allocated to the performance of experiments in preflight mission planning. In the event of real-time requirements for additional time to complete high-priority experiments, for supplementary crew rest periods, or for other contingencies, lower priority activities could be delayed until later in the mission or postponed until AAP-3A; this will undoubtedly be done anyway, whether formal allocations of "mission evaluation" time exist or not.

This alternate approach amounts to eliminating "mission evaluation" periods from preflight mission plans in favor of heavier reliance on real time contingency planning. It is used in the present study to assess the degree to which it might increase the number of AAP-1/AAP-2 experiments that can be completed under nominal conditions on the first AAP mission.

Aside from the exceptions noted previously in this section, scheduling ground rules employed are those established by MSC FCOD as published in the current Baseline Reference Mission document (Reference 13).

4.0 Experiment Scheduling

If the scheduling assumptions discussed above are used, the crew timelines constructed by Martin/Denver contain scheduling opportunities for a significant portion of all experiments not scheduled in Reference 2. One set of such opportunities are shown in Appendix A to demonstrate their existence. Changes made to the basic Martin timelines involved 10 of the 28 mission days of AAP-1/AAP-2; only timelines for these 10 days have been included in Appendix A.

5.0 Results and Recommendations

Modifications to the Martin/Denver timelines made in the present study indicate the following:

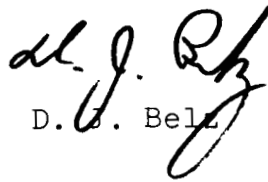
1. Experiment S149 - "Particle Collection," which has replaced S018 - "Micrometeoroid Collection," can be completely scheduled. Scheduling opportunities for this experiment are primarily the result of relaxation in MSC's ground rule governing command module occupancy.
2. The elimination of "mission evaluation" periods from preflight mission planning will permit all of Experiment T020 - "Foot Controlled Maneuvering Unit" to be scheduled on a nominal AAP-1/AAP-2 mission as well as 50% of M508 - "Astronaut EVA Hardware Evaluation" and 50% of M509 - "Astronaut Maneuvering Equipment."*
3. Experiments S019 - "UV Stellar Astronomy" and S020 - "X-Ray/UV Solar Photography" can be completely scheduled if it is found that they are entirely operable by one man and at least portions of existing mission evaluation periods are deleted.

Scheduling opportunities for Experiment S073 - "Gegenschein/Zodiacal Light" cannot yet be assessed for lack of definite scheduling requirements.

It is recommended that the need for weekly "mission evaluation" periods in AAP crew timelines be reexamined with a view toward their possible elimination from preflight mission plans.

1025-DJB-dcs

Attachments


D. G. Bell

*The recent cancellation of the USAF's Manned Orbiting Laboratory (MOL) Program will presumably result in the cancellation of Experiments D019 - "Suit Donning and Sleep Station Evaluation" and D020 - "Alternate Restraints Evaluation." If these experiments are cancelled, their deletion from the crew timelines of Reference 2 would permit an additional run of Experiment M508 to be scheduled, on mission day 20; this would in turn permit as much as two-thirds of M508 to be completed during a nominal AAP-1/AAP-2 mission.

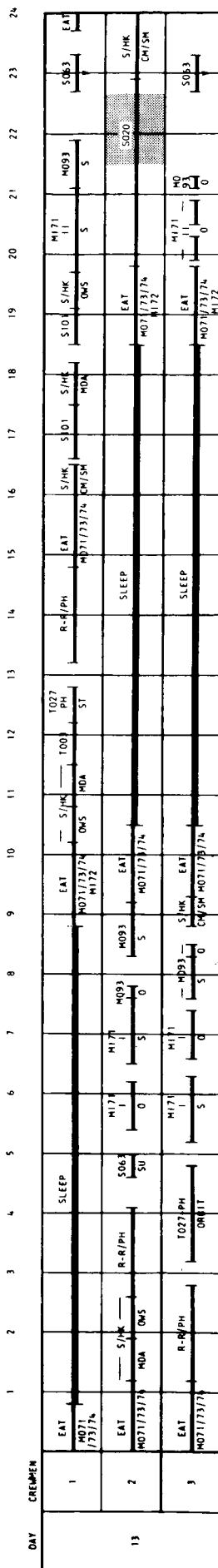
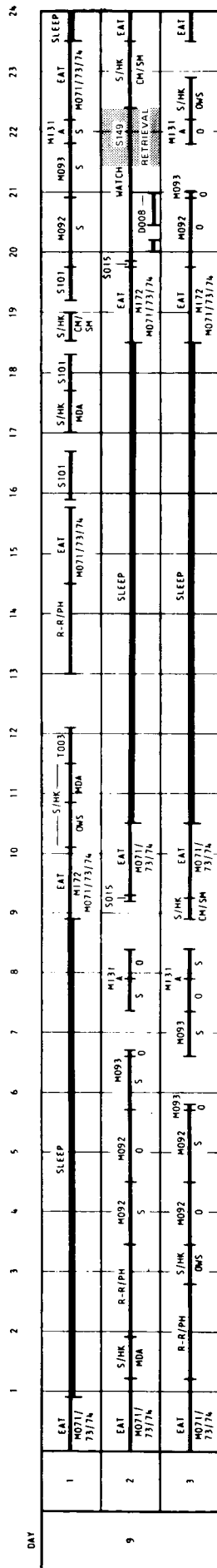
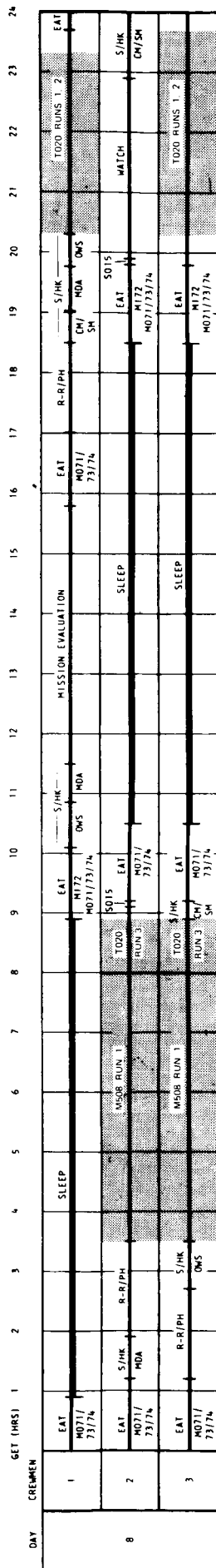
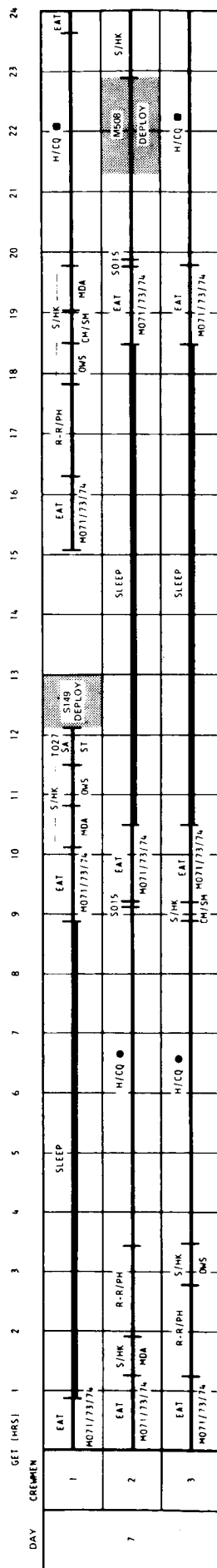
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References

1. Manned Space Flight Schedules, Volume I - Level 1: Schedules and Resources Summary, NASA/OMSF, May 6, 1969. Sensitive.
2. Preliminary Reference Flight Plan: AAP-1/AAP-2, Martin Marietta Corporation/Denver, April 26, 1969.
3. B. E. Ferguson - MSC/CF34, Personal Communication, May 23, 1969.
4. Meeting 69-3, Manned Spaceflight Experiments Board (MSFEB), NASA Headquarters, May 5, 1969.
5. EIRD* for Experiment M508 - "Astronaut EVA Hardware Evaluation," MSFC, April 30, 1969.
6. EIRD for Experiment M509 - "Astronaut Maneuvering Equipment," MSFC, December 12, 1968.
7. ERD** for Experiment S019 - "UV Stellar Astronomy," MSC, April 1, 1969.
8. ERD for Experiment S020 - "X-Ray/UV Solar Photography," MSC, April 1969.
9. T. C. Tweedie, Personal Communication, May 28, 1969.
10. Experiment Implementation Plan for S149 - "Particle Collection," NASA, January 31, 1969.
11. EIRD for Experiment T020 - "Foot Controlled Maneuvering Unit," MSFC, April 23, 1969.
12. AAP Mission Constraints Working Group Meeting, MSC, May 15, 1969.
13. Baseline Reference Mission: AAP-1/AAP-2; AAP-3A; AAP-3/AAP-4, MSC, December 15, 1968.

*EIRD = Experiment Integration Requirements Document.
**ERD = Experiment Requirements Document.

APPENDIX A--MODIFICATIONS TO THE TIMELINES OF REFERENCE 2.



DAY	CREWMEN	GET (HRS)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
14	1	EAT				SLEEP					EAT	M172 MO71/73/74	OMS	S/HK		S020		EAT	MO71/73/74	R-R/PH	CH/SM	MDA	OMS		MS08 RUN 4	EAT
	2	EAT	S/HK	R-R/PH				MS08 RUN 2			EAT	MO71/73/74				SLEEP						EAT	S020		S/HK	CH/SM
	3	EAT	R-R/PH	S/HK				MS08 RUN 2			S/HK	EAT	MO71/73/74			SLEEP						EAT			MS08 RUN 4	

DAY	CREWMEN	GET (HRS)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
15	1	EAT				SLEEP					EAT	M172 MO71/73/74	OMS	S/HK		S020		EAT	MO71/73/74	R-R/PH	CH/SM	MDA	OMS		MS08 RUN 4	EAT
	2	EAT	S/HK	R-R/PH					M171		EAT	MO71/73/74				SLEEP						EAT	S020		S/HK	CH/SM
	3	EAT	R-R/PH	S/HK					M171		S/HK	EAT	MO71/73/74			SLEEP						EAT			MS08 RUN 4	

DAY	CREWMEN	GET (HRS)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
19	1	EAT				SLEEP					EAT	M172 MO71/73/74	OMS	S/HK		MS07		EAT	MO71/73/74	R-R/PH	CH/SM	MDA	OMS		MS08 RUN 4	EAT
	2	EAT	S/HK	R-R/PH					M171		EAT	MO71/73/74				SLEEP						EAT	S063		S/HK	CH/SM
	3	EAT	R-R/PH	S/HK					M171		S/HK	EAT	MO71/73/74			SLEEP						EAT			MS08 RUN 4	

DAY	CREWMEN	GET (HRS)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
21	1	EAT MO711/73/74			SLEEP						EAT M172 MO711/73/74		S/HK OWS MOA	SOT19			SOT19	EAT MO711/73/74	R-R/PH		S/HK CM SM		SOT19			
	2	EAT MO711/73/74	S/HK MOA	R-R/PH				MSOB RUN 3		MSOB STOW	EAT MO711/73/74					SLEEP					EAT M172 MO711/73/74		MSOB RUN 1			
	3	EAT MO711/73/74		R-R/PH	S/HK			MSOB RUN 3		S/HK CM SM	EAT MO711/73/74					SLEEP					EAT M172 MO711/73/74		MSOB RUN 1			

DAY	CREWMEN	GET (HRS)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		
22	1	EAT MO71/73/74				SLEEP					EAT MO71/73/74	— S/HK ONS	MOA	— S019			EAT MO71/73/74		R-R/PH	— S/HK ONS	MOA	— S/HK ONS	MO92	— S M171	— S M171	— S M171	EAT M131	
	2	EAT MO71/73/74				MO92			MO92		MO93	EAT MO71/73/74				SLEEP					EAT							S/HK M171
	3	EAT MO71/73/74				MO92			MO92		MO93	S/HK ONS	EAT MO71/73/74			SLEEP						EAT		MO92	— S M171	— S M171	— S M171	— S M171

DAY	GET (HRS)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24				
28	CREWMEN																												
	1	EAT MO7173/74				SLEEP				EAT MO7173/74	S/HK MO7173/74	CM/SM SYSTEMS CHECKS				S/HK CM/SM	R-R/PH	EAT MO7173/74	▲			CM/SM UNDOCKS & SEPARATES FROM OA	PS1 IMU ORIENTATION	MCC UPDATE	SYSTEMS CHECKS	PS2 IMU REALIGN	EMS TEST	FINAL ENTRY PREP	MANVR TO DEORBIT ATTIT
	2	EAT S/HK MOA	R-R/PH			AM/STS DEACTIVATION ●		MOA DEACTIVATION ●	EAT MO7173/74				SLEEP						EAT MO7173/74	▲									
	3	EAT R-R/PH	STAB DEPLOY			AM/STS DEACTIVATION ●		MOA DEACTIVATION ●	EAT MO7173/74				SLEEP						EAT MO7173/74			CM/SM SYSTEMS CHECKS							

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